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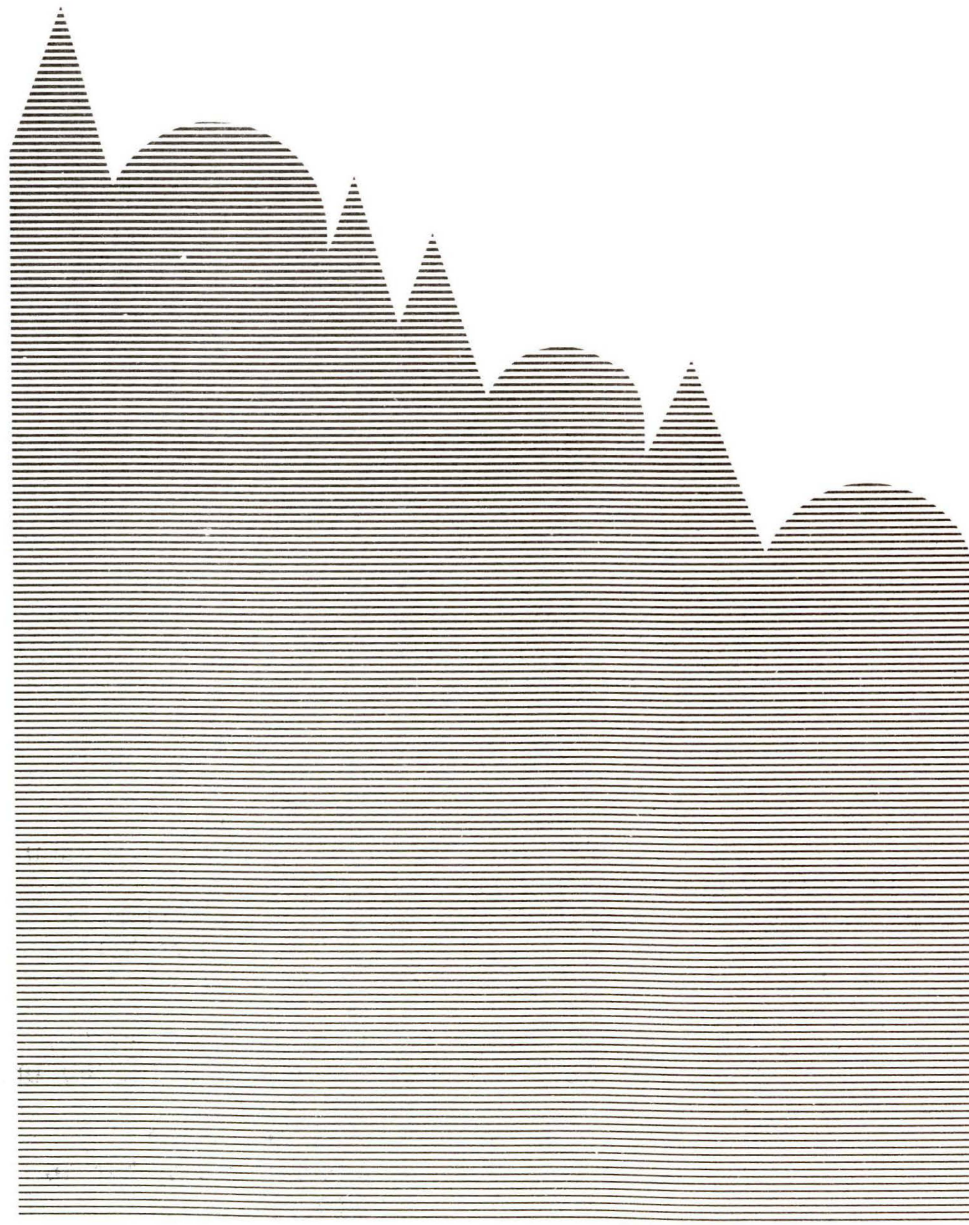
Timberland Area Change in the Lake States:

Past Trends, Causes, and Projections

Andrew Plantinga, Joseph Buongiorno, Ralph J. Alig, and John S. Spencer, Jr.



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Timberland Area Change in the Lake States: Past Trends, Causes, and Projections

Andrew Plantinga, Joseph Buongiorno,
Ralph J. Alig, and John S. Spencer, Jr.

For many people, the word "rural" brings to mind images of cornfields, barns, and silos. Others may think of forests or undisturbed places with few signs of civilization. Such pastoral and pristine settings, even in these times of industrialization and high technology, still exist. However, they are subject to increasing pressures from a developing, industrial society. In some rural areas, these pressures have visibly changed the appearance of the land, and have brought about other changes that are less readily apparent.

In the Lake States (Michigan, Wisconsin, and Minnesota), the area of timberland[1] has declined by approximately 3 million acres over the past two decades (table 1). This decrease has many implications for the region's capacity to supply forest products and provide outdoor recreation. By analyzing the changes that have taken place in rural areas in recent years, we can better understand and predict the patterns of forest land use that will prevail in the future.

[1] *See Appendix I for definitions of terms.*

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Table 1.—*Area of land by land class, Lake States*

(In thousand acres)

Land class	Mid-1960's	Early 1980's	Change	Percent change
Forest				
Timberland	48,806	45,944	-2,862	- 5.9
Woodland	3,142	2,423	-719	-22.9
Reserved	815	2,062	+1,247	+153.0
Total	52,763	50,429	-2,334	-4.4
Nonforest				
Cropland				
Pasture/ rangeland				
Other				
Total	69,793	71,512	+1,719	+2.5
Total land	122,556	121,941	-615	-0.5

Notes: The data were derived by adding land area data for Michigan, Wisconsin, and Minnnesota, Chase *et al.* (1970), Jakes (1980), Spencer (1983), Spencer and Thorne (1972), Spencer *et al.* (1988), Stone (1966). The mid-1960's column represents the sum of land area data for the following states and years: Michigan, 1966; Wisconsin, 1968; Minnesota, 1962. The early 1980's column represents the sum of land area data for the following states and years: Michigan, 1980; Wisconsin, 1983; Minnesota, 1977.

In this paper we will briefly overview the forest acreage situation in each of the Lake States, and discuss the major factors affecting land use trends. After reviewing the available research, we will project future timberland changes in part through use of a statistical model and discuss the implications of these changes.

OVERVIEW OF FOREST ACREAGE CHANGES IN THE LAKE STATES

This brief look at the changes in forest area in Michigan, Wisconsin, and Minnesota is based on data collected by the Forest Inventory and Analysis (FIA) unit at the North Central Forest Experiment Station in St. Paul, Minnesota. In addition to changes in forest area, corresponding changes in ownership and other land classes are examined, along with changes in population and income levels in the Lake States. (An analysis of area changes by FIA survey unit is given in Appendix II. This detailed examination provides a more complete picture of forest area changes in the Lake States.)

Michigan

Although half of Michigan's land is still covered by forests (table 2), in recent years the area of this forest has been decreasing. Between 1966 and 1980, the area of timberland fell from 18.9 million acres to 17.5 million acres, a decrease of 7 percent. At the same time, the area of reserved timberland increased by 0.3 million acres and woodland increased by 0.05 million acres.

While timberland area decreased, the area of cropland increased by 2.6 million acres between 1966 and 1980. During that time, pasture/rangeland and "other" land decreased by 1.4 million acres.

About 36 percent of Michigan's timberland is publicly owned (table 2). Of the privately owned timberland, miscellaneous private owners hold the biggest share (about 35 percent), followed by farmers (about 18 percent) and forest industry (about 11 percent).

The decrease in timberland occurred across all ownership categories. Between 1966 and 1980, the holdings of miscellaneous private owners showed the biggest decline, 0.5 million acres. The next largest reduction was for farm forest, 0.4 million acres, followed by forest industry with 0.3 million acres. Publicly owned lands decreased by 0.2 million acres.

Wisconsin

Approximately 44 percent of Wisconsin's land area is covered by forests (table 3). In the 15-year period from 1968 to 1983, the amount of forest area increased by 0.4 million acres, a gain of about 3 percent. Timberland and reserved timberland each showed increases of about 0.2 million acres, while the amount of woodland declined by less than 0.1 million acres.

Table 2.—*Area of land by land class and ownership, Michigan*

(In thousand acres)

Land or ownership class	1966		1980		Change
Forest					
Timberland	18,857		17,490		-1,367
Woodland	205		257		+52
Reserved	311		622		+311
Total	19,373		18,369		-1,004
Nonforest					
Cropland	9,714		12,293		+2,579
Pasture/ rangeland	1,625		1,339		-286
Other	5,780		4,363		-1,117
Total	17,119		17,994		+875
Total land	36,492		36,363		-129
		Percent of total		Percent of total	
Timberland by owner					
Public	6,440	34	6,267	36	-173
Forest industry	2,257	12	1,981	11	-276
Farmer	3,530	19	3,098	18	-432
Misc. private	6,673	35	6,144	35	-529
Total	18,900	100	17,490	100	-1,410

Notes: The data sources were Chase *et al.* (1970) and Spencer (1983). The 1966 data were adjusted to conform to 1980 areas because of changes in survey procedures and definitions, except timberland areas by owner class, which are unadjusted.

Increases in forest area were mirrored by decreases in nonforest land, particularly nonforest land termed "other." This "other" land declined by 1.4 million acres between 1968 and 1983, while cropland and pasture/ rangeland showed increases of 0.7 and 0.3 million acres, respectively.

Between 1968 and 1983 there were notable changes in the ownership structure of Wisconsin's timberland (table 3). Most dramatic was a 1.3 million acre decline in farm holdings and an increase in miscellaneous private ownership of 1.7 million acres. The amount of publicly owned timberland remained essentially constant during this period, while forest industry holdings declined by 0.2 million acres. By 1983, miscellaneous private owners held the largest percentage of the timberland (38 percent), followed by public owners (31 percent), farmers (24 percent), and forest industry (7 percent).

Table 3.—*Area of land by land class and ownership, Wisconsin*

(In thousand acres)

Land class	1968		1983		Change
Forest					
Timberland	14,537		14,759		+222
Woodland	374		331		-43
Reserved	34		261		+227
Total	14,945		15,351		+406
Nonforest					
Cropland	12,043		12,712		+669
Pasture/ rangeland	1,845		2,129		+284
Other	6,025		4,640		-1,385
Total	19,913		19,482		-431
Total land	34,858		34,833		-25
		Percent of total		Percent of total	
Timberland by owner					
Public	4,526	31	4,521	30	-5
Forest industry	1,368	10	1,156	8	-212
Farmer	4,809	33	3,514	24	-1,295
Misc. private	3,834	26	5,568	38	+1,734
Total	14,537	100	14,759	100	+ 222

Note: Data are from Spencer and Thorne (1972) and Spencer *et al.* (1988).

Minnesota

Approximately 33 percent of Minnesota's land is covered by forests (table 4). In 1977, the area of these forests was 16.7 million acres, down by 1.7 million acres from 1962. The timberland category showed the largest decrease, 1.7 million acres, followed by woodland, which lost 0.7 million acres. Reserved timberland increased by 0.7 million acres during this time. Jakes (1980) stated that about 0.67 million acres of timberland became reserved timberland, largely as a result of additions to the Boundary Waters Canoe Area Wilderness and the creation of Voyageurs National Park.

Between 1962 and 1977, there were only small area changes across ownerships of Minnesota's timberland (table 4). In 1962 the public owned the greatest share of the timberland, 56 percent. In 1977, this figure was 54 percent. Farm holdings increased slightly during this period, from 20 percent of the timberland to 25 percent. Miscellaneous private owners lost some of their timberland, falling from 20 percent to 16 percent.

Table 4.—*Area of land by land class and ownership, Minnesota*

(In thousand acres)

Land class	1962		1977		Change
Forest					
Timberland	15,412		13,695		-1,717
Woodland	2,563		1,835		-727
Reserved	470		1,179		+709
Total	18,445		16,709		-1,736
Nonforest					
Total	32,761		34,036		+1,275
Total land	51,206		50,745		-461
		Percent of total		Percent of total	
Timberland by owner					
Public	9,539	56	7,328	54	-2,211
Forest industry	715	4	772	6	+57
Farmer	3,344	20	3,404	25	+60
Misc. private	3,464	20	2,191	16	-1,273
Total	17,062	100	13,695	100	-3,367

Notes: The data were taken from Jakes (1980) and Stone (1966). The data for 1962 were adjusted to conform to 1977 areas because of changes in survey procedures and definitions, except timberland areas by owner class, which are unadjusted.

PATHWAYS OF AREA CHANGES FOR LAND USES

A study by Dideriksen *et al.* (1977) considered the Lake States as one region and estimated the exchanges between cropland, pasture and rangeland, forest land, and "other" land between 1967 and 1975. In this study, the definition of forest land was similar to that of timberland in the FIA surveys. However, "other" land was defined more precisely as "parts of farms not used for growing crops, such as roads, farm residences, etc., and rural nonfarm residences and land considered part of these residences." Urban land was considered separately and estimates of acreages converted to urban uses were given. The findings revealed decreases in cropland and forest land of 5 and 8 percent, respectively, and no change in the amount of pasture and rangeland. However, the amount of "other" land increased by 60 percent, due primarily to conversion of forest land. Forest land contributed 2.5 million acres to this "other" category between 1967 and 1975, while cropland and pasture/ rangeland added only 1.4 million and 1.0 million acres, respectively. Of all the converted acres of forest land, the greatest amount was added to the "other" land

category; only 0.3 million acres of forest land were converted to cropland, 0.6 million acres to pasture and rangeland, and 0.2 million acres to urban uses.

Dideriksen's findings suggested that declines in forest land area in the Lake States were due to conversions for development in rural areas, specifically farm and nonfarm residences. These findings make sense given the high percentage of private timberland owners, some of whom may have converted their land for residences.

A study by Zeimetz *et al.* (1976) of six counties in the Lake States reached similar conclusions. These counties, which were adjacent to large metropolitan centers, experienced dramatic population growth between 1960 and 1970. During this time, cropland and forest land showed net declines of 8 and 1 percent, respectively, primarily as a result of conversion to urban uses such as residential housing, transportation, and commercial and industrial development. This study illustrated the marked growth of suburbia in rural areas surrounding large cities. As population increased in these areas, rural lands were converted for new housing and transportation systems. In addition, there appeared to be an influx of industry and other commercial services to accommodate the new residents. The result was a decline in the acreage of rural lands.

FACTORS INFLUENCING REGIONAL LAND USE CHANGES

Several studies have addressed the issue of forest area trends in the Lake States. The FIA units of the USDA Forest Service have monitored forest area changes in individual states (e.g., Jakes 1980, Wall 1981), while other studies (Dideriksen *et al.* 1977 and Zeimetz *et al.* 1976) have estimated the exchanges between land classes. Although a large number of books and articles have discussed the factors that influence trends in forest area, few studies have provided empirical estimates of the relative contributions of these factors to changes in forest area. Among them, those related to population and economic trends are thought to be dominant. Although the two are related, they are discussed separately for convenience.

Demographic Trends

Recent demographic data suggest that populations in the Lake States are shifting away from large cities and into more rural areas (fig.1). This change is evidenced most notably in decreases in populations of large urban centers and increases in populations of smaller urban areas. People also appear to be moving to areas which border cities, suburbs, or the metropolitan fringe. Some of this apparent population shift may be due to changes in the definition of urban population, but truly remote and rural areas are also showing population increases. For example, the rural population of northeastern Wisconsin increased by 24 percent between 1970 and 1980, compared with a total State population increase of 6.5 percent during that period.

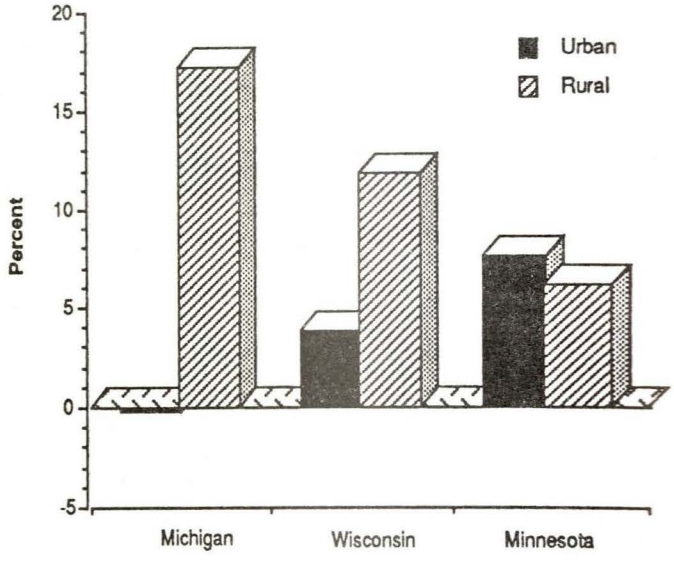

Figure 1.—*Percentage change in rural and urban populations by State, 1970-1980.*

How can these changes be explained? One crucial factor is transportation. With the improvement and expansion of the highway network, rural areas are much more accessible from urban centers and vice versa. This, according to Raup (1980), has created the new land class we call suburbia. Improvements in the transportation system have also played a central role in the deconcentration of industry. Between 1970 and 1976, manufacturing jobs in nonmetropolitan areas in the United States grew by 8 percent, while the number in metropolitan areas fell by 5 percent (Healy and Short 1981). It is often economically advantageous for industries to be located in rural areas because of lower wage rates and cheaper land (Morrison 1981).

In general, people's attitudes regarding where they prefer to live have been changing. Rural settings and small towns have grown increasingly more attractive to

people. According to Sofranko *et al.* (1981), the five main reasons for urban to rural migration, in order of decreasing frequency, are environmental "push" factors (responses to negative features of urban life), employment-related decisions, retirement, environmental "pull" factors (responses to positive aspects of rural life), and ties to the area (for example, a return to area of birth).

These population shifts have produced dramatic changes in forest land ownership. Evident in recent years is the shift in timberland holdings from farmers to miscellaneous private owners (tables 2, 3, 4). For example, between 1968 and 1983, holdings of timberland by farmers in Wisconsin decreased by 27 percent, while timberland held by other miscellaneous private owners rose by 45 percent. These miscellaneous private owners are a diverse group, from corporations to individuals from a wide range of socioeconomic classes. An increasing number of these individuals are retired.

These new owners of rural land have different motives for owning the land than did traditional owners such as farmers. According to Sofranko *et al.* (1981), the main attractions for rural emigrants are nonagricultural aspects of country life. Consequently, these lands are often purchased for recreation and for second homes. They are also used for inflation hedging and in some cases for speculation—the purchase of land in order to sell it at a higher price. Clawson (1979) states that speculation is a main objective for many private forest landowners.

Because of the emphasis on nonagricultural uses, there has been an increase in the demand for small parcels of land. According to Healy and Short (1981), parcels of 5 to 40 acres are very popular, and demand for these small plots has resulted in subdivision of large acreages into smaller ones. Healy (1984) reported that in Michigan certain zoning laws imposing a 10-acre minimum for lots have resulted in a dramatic increase of 10.1-acre lots.

In summary, population affects land use trends in three ways. First, increases in population create greater demand for land development, which in turn increases relative land rents for land with development potential. The result is urban expansion and a subsequent decrease in forest acreage. Urban-to-rural shifts in population influence land usage in much the same way as increases in population. When the population shifts, demand is created for housing and development in rural areas. This demand increases the land rents in areas with development potential and leads to a reduction in forest area. If agricultural land is converted for urban expansion, then forest will often be converted to agricultural uses to replace the lost acreage. Finally, growth in population increases the number of rural land buyers, which may increase the number of miscellaneous private forest landowners.

Economic Factors

The level of personal income in the Lake States historically has been above the U.S. average, but it dropped from 113 percent of the U.S. average in 1950 to 107 percent in 1982. Per capita income (in constant dollars) has more than doubled in the Lake States region since 1950 (USDC 1982). There has been a fairly constant relationship between the level of personal income, on average, and Gross National Product (GNP).

Increasing per capita income likely causes upward pressure on land rents for developed uses. Changes in per capita income also can cause changes in the distribution of timberland among owner groups. The nonindustrial private forest (NIPF) landowner class (comprised of farmers and miscellaneous private owners) has shifted notably in the past two decades toward a majority of miscellaneous private owners. Increased capital availability may increase investment demand by miscellaneous private owners. Mullaney and Robinson (1980) suggest that business and professional individuals have relatively higher incomes and are more likely to invest in forestry than other NIPF landowners.

Land productivity and size of land parcel also influence changes in use. When a landowner decides to utilize his or her land for timber production, there is an implicit opportunity cost related to other possible uses of the land. Comparably, land used for timber production has a very low value. Healy (1984) outlines a land use hierarchy system and provides typical per acre land values. Urban uses top the chart with a per acre value of $5,000 to $50,000+. Orchards and specialty crops are next, followed by other agricultural uses. Timber production, (with a bare-land value of $100 to $600) is second to last, ahead of rangeland grazing. A fundamental problem with successful timber production is the need for a large amount of land. According to Healy and Short (1981), at least 1,000 acres of good-quality timberland is typically required to derive a steady income from timber sales. They also point out that, in contrast to farm commodities, there is no government price support for timber. There are, however, a variety of tax incentive programs for timberland owners at the State and national level.

Land conversion pressures tend to be the most acute for NIPF landowners (Wall 1983). Many of them do not own timberland to produce timber; consequently, they can convert their land to other uses since they are not economically constrained to grow trees on it. For those who do manage for timber production, the likelihood of realizing significant returns in many cases is not high. Most NIPF landowners lack knowledge about effective silvicultural practices and as a result may produce low-value timber (Clawson 1979). In addition, because many NIPF land holdings are too small to make timber production economically feasible, these owners run into problems when they sell their wood. As Clawson (1979) points out, the bargaining strengths of the NIPF landowner and the timber buyer are often not equal.

Overall, many NIPF landowners are not willing to make a long-term commitment to timber production. And even if they are committed, their prospects are not always very good. As Clawson (1979) writes, "Land speculation and the purchase of forests for non-forestry purposes have pushed the price of forest land in many areas to levels so high that a purchaser cannot hope to grow wood and from wood-growing alone make a good return on his investment." Quite simply, the NIPF landowner may have, in purely economic terms, more promising opportunities.

A STATISTICAL MODEL OF TIMBERLAND AREA CHANGES

Model Specification

Positive models of land use change describe land use as it relates to economic, social, and other variables. Econometric techniques are frequently used to quantify the relationships. Neoclassical economic theory is often used to select variables in positive models of land use. For example, White and Fleming (1980) and Alig (1986) rely on land rent theory of the form:

$$f_{jt} = g(R_{1t},...,R_{jt}; Z_t), \qquad (1)$$

where land in use category j at time t, f_{jt}, is a function of rents, R_{jt}, for all feasible uses (j=1,...J) and exogenous factors Z_t.

For this study a simple model was constructed regressing the change in timberland area on changes in the levels of rural population and median family incomes, and the percent of total land covered by timberland. Similar approaches have been taken by Alig and Healy (1987) and Berck and Parks (1987).

These variables were selected for two reasons: (i) they appeared to underlie most of the factors used in past literature to explain changes in timberland area, and (ii) in terms of projections, population and income are the only regional variables for which one realistically may hope to have long-term forecasts. According to the hypotheses detailed below, all of these variables were expected to be negatively correlated with changes in timberland area. The model was specified as follows:

$$CTMBL_i = a + b\ CRPOP_i + c\ CFINC_i + d\ LRPOP_i + e\ LFINCi + f\ PTMBL_i + U_i \qquad (2)$$
$$i=1,...,N$$

where i refers to a county, N equals 154 counties in Wisconsin and Michigan, CTMBL is the change in the area of timberland, CRPOP is the change in rural population, CFINC is the change in median family incomes, LRPOP is the base-year level of rural population, LFINC is the base-year level of median family incomes, and PTMBL is the percent of total land covered by timberland.

Model (2) can be viewed as a reduced form of (1), in which the rent variables are themselves functions of Z_t, and Z_t consists of population and income. Model (2) embodies three different hypotheses regarding the effects of population and income on changes in timberland area. These variables were also determined by Alig (1986) to be the most important factors influencing timberland acreage trends in the Southeast. Other authors have also emphasized their importance (e.g., Parks 1987). Other variables, such as State and Federal timberland tax relief programs, may be important too. However, data were not available to measure these effects.

The first hypothesis concerns the deconcentration of population in the form of urban-to-rural emigrations. According to Morrison (1981) and Sofranko *et al.* (1981), these demographic shifts have occurred in the Midwest. An examination of population data for 1960, 1970, and 1980 confirmed that rural populations have increased and urban populations have fallen or remained stable in the Lake States (U.S. Bureau of Census, 1963a, 1963b, 1973a, 1973b, 1982a, 1982b).

One effect of this rural population growth has been a decline in forest area (Healy 1984). More specifically, forests have been converted for housing and other developments in rural areas (Dideriksen *et al.* 1977). In addition, forests have been converted for services

(e.g., stores and businesses), and some have been designated as recreational lands to accommodate growing rural populations. Hence, it was expected that increases in rural population would lead to declines in the area of timberland. For similar reasons, it was expected that timberland area changes would be greater in counties with higher rural populations, since demands for housing and services would result in the conversion of timberland.

The second hypothesis regarded income change and income levels, variables expected to be negatively correlated with timberland acreage changes. According to Morrison (1981), industries in the Midwest have moved to rural areas to take advantage of cheaper and more available land. We have hypothesized that when firms move into an area, the average income of the area's residents will increase along with their demand for housing and services. Accordingly, timberland area will decline when it is converted to these other uses. Similarly, it is expected that timberland area declines will be greatest in counties with the highest levels of income.

The third hypothesis embodied in model (2) regarded the percent of total land covered by timberland. This variable was expected to be inversely related to timberland area changes. Counties with high percentages of timberland would have a larger potential for declines in timberland simply because there is more total acreage in these counties. In addition, timberland in these counties will be relatively inexpensive, making it more likely to be converted when the demand for alternative land use increases.

The sources for the data are as follows: The timberland area data were taken from USDA Forest Service FIA surveys (Chase *et al.* 1970, Spencer 1983, Spencer and Thorne 1972, Spencer *et al.* 1988) and represent the years 1966 and 1980 in Michigan and 1968 and 1983 in Wisconsin. Minnesota survey units were changed between the 1962 survey (Stone 1966) and the 1977 inventory (Jakes 1980). Also, adjustments made to 1962 State totals to make them comparable to 1977 data could not be made at the county level. Consequently, county data could not be compared and Minnesota data were excluded. The population and income data were obtained from U.S. Bureau of Census reports for the years 1960, 1970, and 1980 (U.S. Bureau of Census 1963a, 1963b, 1973a, 1973b, 1982a, 1982b). The population and income data were interpolated or extrapolated to correspond to the years of the timberland area data.

Results

The above model, estimated by ordinary least squares (OLS) using pooled Michigan and Wisconsin data, revealed significant correlations based on a 5-percent significance level between the change in timberland area and the level of income and percentage of timberland (table 5). In both cases, the coefficients were negative. Timberland area declines were greater in counties with higher incomes and higher percentages of total land covered by timberland in the base year (1960's). The other independent variables, change in population and income and the level of population, appeared to significantly influence timberland area changes only at a 25-percent significance level. The coefficients of population change and the population level were negative, indicating that timberland area declined more in counties that experienced greater population growth and had a greater level of population.

The coefficient for income change was positive, contrary to expectations. This result suggested that timberland area declines were greater in counties where income changes were smaller. The R-squared ratio was low. Only 31 percent of the change in timberland acreage was explained by the independent variables, showing that other unspecified factors were involved in influencing timberland area change.

PROJECTIONS OF CHANGES IN TIMBERLAND AREA

Projections of timberland area change in the Lake States presented in this section are based on a blend of qualitative information and the regression equations discussed in preceding sections (Alig *et al.* 1989). Model (2) was used only as a guide to making projections because of its low explanatory power. The results of timberland area projections appear in table 6. They indicate a slower rate of decrease than in recent decades, a net decrease of 1 percent in timberland area projected by the year 2040.

There are many reasons why the rate at which timberland has been declining in the past two decades can be expected to decrease. One reason is that population growth in the Lake States region has been decreasing. According to a recent demographic study (Minnesota State Demographer 1988), average population growth rates between 1980 and 1987 were (-)0.7 percent in Michigan, 2.1 percent in Wisconsin, and 4.2 percent in Minnesota, compared with a national average of 7.4 percent.

Table 5.—*Regression results for timberland area changes in the Lake States*

Variable	Coefficient	Standard deviation of the coefficient	T-Ratio
Constant	72.21	16.87	4.70*
Change in rural population in thousands (CRPOP)	- .33	.30	-1.11
Change in median family incomes in thousand dollars (CFINC)	1.74	1.33	1.31
Level of rural population in thousands (LRPOP)	-.25	.15	-1.70
Level of median family incomes in thousand dollars (LFINC)	-9.05	2.89	-3.13*
Percentage of timberland (PTMBL)	-.74	.10	-7.18*

R-squared = 31.2 percent, adjusted for D.F.
Number of observations = 154 counties

Notes: * Indicates coefficients significantly different from zero at the 5-percent significance level. Population and income data were used from 1960, 1970, and 1980 Censuses and interpolated or extrapolated to correspond to years 1966 and 1980 in Michigan and 1968 and 1983 in Wisconsin. Changes were measured between 1966 and 1980 in Michigan and 1968 and 1983 in Wisconsin. The levels of the rural population and median family income variables and the percentage of timberland were for 1966 in Michigan and 1968 in Wisconsin.

Table 6.—*Area of timberland in mid-1960's, early 1980's, and 1987, and projections to 2040, by state, Lake States*

(In thousand acres)

Years	Lake States	Michigan	Wisconsin	Minnesota
Mid-1960's	48,806	18,857	14,537	15,412
Early 1980's	45,944	17,490	14,759	13,695
1987	45,640	17,341	14,727	13,572
2000	45,414	17,281	14,709	13,424
2010	45,313	17,261	14,690	13,362
2020	45,232	17,241	14,664	13,327
2030	45,167	17,231	14,630	13,306
2040	45,155	17,252	14,598	13,305

Notes: The 1987 estimate is from the 1989 Resources Planning Act (RPA) Assessment (USDA Forest Service (1989)). Because the projections are preliminary and currently undergoing review, they are subject to revision.

Second, construction of the transportation systems (e.g., highways) that claimed a large amount of timberland in the past three decades is near completion, so that timberland converted for these purposes in the future will probably decrease. According to Raup (1980), existing highways will be improved during the rest of this century, but the construction of many new roads is not likely.

Third, development of rural areas, which has occurred in dramatic proportions, can be expected to gradually decrease. As Raup (1980) says, "The short-term prospect is for a substantial reduction in the pressure of urban demand on rural lands." Even if migratory trends away from urban centers and into rural areas continue, less development will be needed (relative to the amount of development required initially) to accommodate the larger populations. Many services created for the "first wave" of urban emigrants can expand to accommodate more emigrants without requiring as much timberland conversion.

In addition, NIPF landowners will quite likely want to reserve some of their forests from development in the future. For example, a timberland owner who converts some of his or her land for a second home or for recreation will probably want to preserve some or all of the remaining forest because of its amenity value. Although some conversion of forests is likely to continue, when the benefits from the remaining forests (which are often the reason for development in the first place) are threatened, development will slow or cease.

Finally, the rate at which timberland is lost to agricultural expansion can be expected to decrease, since there is currently substantial excess capacity in the agricultural sector. Even if the population continues to grow and demand for agricultural products increases, technological advancements in farming may allow for sufficient yields from lands already used for farming. However, this issue is not altogether clear. Shulstad and May (1980) feel that the rate of growth of agricultural yields is decreasing and expansion for cropland will be necessary in the future, although they find some evidence to the contrary. In addition, unforeseeable climatic events (e.g., persistent droughts) and international trade developments (Alig *et al.* 1987) can exert significant pressure on agricultural prices and thereby influence land conversion.

Area changes in timberland are likely to occur within different ownership categories. The amount of timberland owned by forest industry most likely will increase gradually in the future to meet the forecasted increase in demand for forest products. However, this increased demand will for the most part be met by improving the productivity of existing forest industry lands (Healy and Short 1981).

An overall decline in timberland area can be expected due to conversion of privately owned timberland to other uses, such as development in rural areas. In the Lake States, farmers and miscellaneous private owners own most of the timberland. Miscellaneous private owners will likely continue to acquire timberland held by farmers and will continue converting it to other uses.

In Michigan, the area of timberland decreased dramatically between 1966 and 1980; however, this decline can be expected to lessen in the future (table 6). Results of studies by Smith and Hahn (1986) and Jakes and Smith (1983) are consistent with a decreased rate of decline in timberland area, as discussed above. Decreases in timberland area are expected among farmers and miscellaneous private owners, while forest industry and public holdings are expected to increase slightly.

In Wisconsin, the area of timberland increased by 1.5 percent between 1968 and 1983; this increase will likely give way to decreases in timberland area by 2000 (table 6). The reason for increases in timberland area in Wisconsin was essentially the reverting of wooded pasture to forest (Spencer *et al.* 1988), and these gains cannot be expected to continue very long. First of all, pasture reverted to forest as a result of a slumping farm economy; they were, in effect, excess lands not needed for agriculture. There are a limited number of acres that can revert to forest, so gains in timberland area from reverted pasture can be expected to gradually decrease. And by the end of this decade, the area of Wisconsin's timberland can be expected to begin decreasing. In the past 15 years, a good deal of land has been transferred to miscellaneous private owners (the ownership group with the highest percentage of timberland). Conversion pressures are thought to affect these owners the most. However, since the public also owns a large percentage of the timberland, the overall rate of decline will probably be small, as in Michigan.

In Minnesota, timberland area has decreased dramatically in the last two decades, a trend that can be expected to continue, although at a lower rate (table 6). Further declines will be limited by the small percentage of forest land held by miscellaneous private owners. With so much publicly owned forest land in the State, rates of decline can be expected to be low.

SUMMARY AND CONCLUSIONS

The literature on land use trends emphasizes demographics and economics, including ownership, as the chief factors affecting changes in the area of timberland. Population increases and shifts away from metropolitan centers result in development in rural areas and a subsequent decline in forest area. The miscellaneous private timberland owner has assumed a prominent role in rural settings. For these owners, timber production is rarely a primary objective and often not a very profitable activity. Consequently, miscellaneous private owners are susceptible to land conversion pressures and are often accountable for declines in forest acreages.

A study of the survey units for Michigan, Wisconsin, and Minnesota confirmed the influences of population, economics, and ownership on timberland acreage trends and revealed systematic relationships between area changes in different land categories. In the Lake States, increases in cropland area reflected decreases in the area of timberland, and vice versa. Increases in the amount of "other" land corresponded to decreases in timberland and an increase in land used for urban purposes. When the amount of "other" land decreased, the area of timberland increased as wooded pasture reverted to forest.

The ownership of timberland in the Lake States was closely related to area trends of all land classes. When the amount of cropland increased in an area, and the timberland area declined, farmer holdings of timberland increased and the holdings of miscellaneous private owners decreased. When the amount of "other" land increased, the area of timberland held by miscellaneous private owners declined as timberland was converted to urban uses. When the area of "other" land decreased, more timberland was available and the holdings of miscellaneous private owners increased. Finally, an influx of people into rural areas was evident in the Lake States. This coincided with increases in the forest holdings of miscellaneous private owners and dramatic changes in rural land ownership.

In the future, declines in timberland area will most likely continue in the Lake States; however, the rate of decline will probably be lower than in the past. Many factors, such as excess capacity in the agricultural sector, tapering off of new highway construction, a relative decline in rural development and agricultural expansion, and an expected decline in the population growth rate, suggest a lower rate of decline in the future.

Several conclusions can be drawn from this study. As expected, the base-year level of income and the percentage of total land covered by timberland were negatively and significantly (5-percent significance level) correlated with timberland area change. This revealed that timberland acreages declined in counties with higher income levels and higher percentages of timberland (table 5). Also according to our hypotheses, changes in and levels of population were negatively correlated with timberland acreage changes. However, these variables were not significantly correlated (5-percent significance level) with timberland area changes. And, as mentioned above, the R-squared ratio was low for this regression, revealing that the independent variables explained only a small part of the changes in timberland area.

This study disclosed some of the problems associated with developing timberland acreage models. The first is the sheer complexity of the issue. As Alig *et al.* (1983) stated, "Major forces that influence land use, such as regional patterns of population growth, diverse goals of landowners, technological change, and demand for agricultural and forest products, interact in ways that are extremely difficult to quantify, much less to project." This study revealed the difficulty of identifying causal relationships between timberland area changes and the variables which appear to facilitate these changes. It was evident that demographic and economic variables by themselves cannot explain changes in timberland area. Whether other variables are involved remains an open question.

An important consideration in building timberland acreage models is the ownership of timberland, since different owners have different motives for owning their land. However, timberland area data by county and ownership group were not available. Another problem was the lack of a detailed matrix showing exchanges between different land classes. While Dideriksen *et al.* (1977) provided a matrix for the entire Lake States region, more detailed data on exchanges between land categories for individual States and for longer time periods were needed to identify the causal forces.

Finally, problems arose when data were used from unrelated surveys. Data had to be adjusted so that dates coincided, introducing error.

A final conclusion of this study regards general concerns for developing models of timberland area change. Clearly, the issue is complex. Indeed, the direction in which the lines of causality run in this case is not obvious. Does a growing rural population cause a decline in timberland area? Or does the existence of forests in a particular area attract new residents and cause the population to grow? Or are the different variables correlated such that particular combinations of these variables yield certain results? Improvements in future studies will rely heavily on more comprehensive data and more frequent remeasurements (Wall 1983) with which to develop timberland acreage models.

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APPENDIX I

Definition of Terms

Cropland.—Land under cultivation, including cropland harvested, failed, fallowed, and idle.

Forest.—Land at least 16.7 percent stocked by forest trees of any size, or formerly having such tree cover, and not currently developed for nonforest use. Includes all land found in the timberland, reserved timberland, woodland, and reserved woodland classes.

Miscellaneous private owners.—Nonindustrial owners of forest land, including nonfarmer individuals and corporations.

Other land.—Urban sites and all land not fitting into other land class categories.

Pasture and rangeland.—Land improved for grazing and land on which the natural plant cover is composed principally of native grasses, forbs, or shrubs valuable for forage.

Reserved timberland.—Forest land sufficiently productive to qualify as timberland, but presently withdrawn from timber utilization by statute or administrative regulation.

Timberland.—Forest land capable of producing crops of industrial wood and not withdrawn from timber production. Must have the capability of producing in excess of 20 cubic feet per acre per year of annual growth under management.

Wooded pasture.—Improved pasture with more than 16.7 percent stocking in live trees but less than 25 percent stocking in growing-stock trees.

Woodland.—Forest land incapable of producing 20 cubic feet per acre of annual growth or of yielding crops of industrial wood under natural conditions because of adverse site conditions.

Source: Spencer *et al.* (1988).

APPENDIX II

Area Changes for Survey Units

The earlier brief overview of the timberland situation in Michigan, Wisconsin, and Minnesota is not sufficient to fully explain the changes that have occurred in these States' forests. Quite simply, the areas considered are much too large. Some areas of Wisconsin, for example, differ greatly from others—northern Wisconsin is heavily forested and sparsely populated, while southern Wisconsin contains large metropolitan centers and much agricultural land. To note that the area of Wisconsin's forests increased 3 percent since 1968 is not presenting the whole picture, since in parts of the north the forest area declined while in the south it increased. For this reason, this Appendix will examine in detail the FIA survey units as determined by the USDA Forest Service (fig. 2). Viewed individually, they provide a better picture of the changes in forest area. When two or more survey units are similar in terms of land use distribution and changes in this distribution, they will be discussed together.

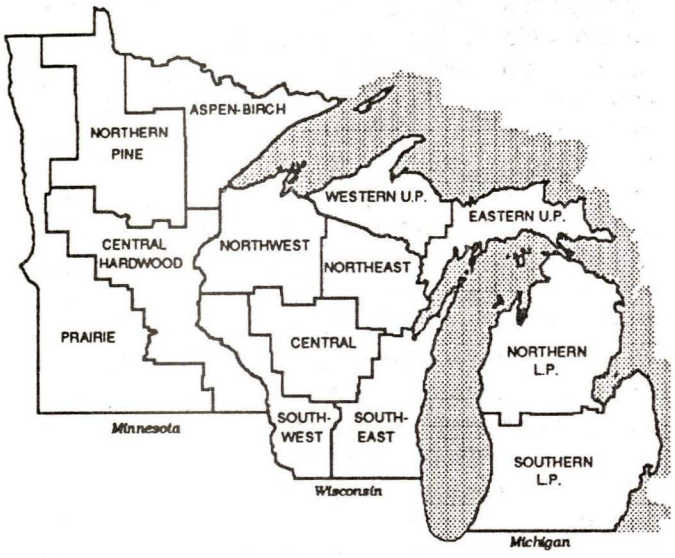

Figure 2.—*Forest Survey units in the Lake States.*

Michigan

Michigan comprises an area of over 36 million acres (table 2). The northern part of the state, made up of the Eastern and Western Upper Peninsula survey units (EUP and WUP), is heavily forested and sparsely populated. Timberland covers over 75 percent of the land in most of the Upper Peninsula (table 7).

In the lower half of the State, comprised of the Northern and Southern Lower Peninsula survey units (NLP and SLP), the population is greater and the area covered by timberland is less than in the Upper Peninsula. Sixty-one percent of the land in the NLP is forested while only 18 percent of the SLP is covered by forests.

Table 7.—*Area of land by land use and FIA survey unit, Lake States*

(In thousand acres)

State and survey unit	Timberland	Woodland	Reserved	Nonforest
Michigan		(1966/1980)		
E.U.P.	4,169 / 3,802	80 / 102	33 / 128	731 / 967
W.U.P.	4,921 / 4,530	77 / 62	185 / 267	389 / 668
N.L.P.	6,955 / 6,695	35 / 88	62 / 147	4,336 / 4,421
S.L.P.	2,812 / 2,463	14 / 5	31 / 81	11,663 / 11,938
Wisconsin		(1968/1983)		
N.E.	4,062 / 3,829	151 / 141	2 / 52	1,467 / 1,679
N.W.	5,246 / 5,151	179 / 166	6 / 115	2,507 / 2,497
Central	2,832 / 2,951	22 / 22	4 / 30	4,344 / 4,168
S.W.	1,493 / 1,920	7 / 0	12 / 39	4,667 / 4,192
S.E.	904 / 909	16 / 3	11 / 25	6,929 / 6,949
Minnesota		(1962/1977)		
A.B.	6,244 / 5,451	1,125 / 970	401 / 1,051	1,065 / 1,162
N.P.	6,025 / 5,758	950 / 707	29 / 47	4,133 / 4,543
C.H.	2,360 / 1,951	351 / 120	37 / 72	9,215 / 9,776
Prairie	783 / 534	136 / 39	4 / 9	18,348 /18,556

Note: These data are taken from Chase *et al.* (1970), Jakes (1980), Spencer (1983), Spencer and Thorne (1972), Spencer *et al.* (1988), and Stone (1966)

In Michigan's Upper Peninsula, survey units EUP and WUP, the area of timberland decreased between 1966 and 1980, while land used for agriculture and "other" land increased. During this time, the EUP and WUP lost 0.37 and 0.39 million acres of timberland, respectively, while gaining 0.95 and 0.82 million acres of reserved timberland. Gains in the reserved timberland category reflected efforts on the part of the State and local governments to set aside parks and recreation areas. Nonetheless, there was a good deal of timberland lost to other uses between 1966 and 1980, particularly cropland and "other" land. Timberland was converted to agricultural uses such as cropland and pasture/rangeland and for rural development to accommodate an influx of new residents in rural areas.

All ownership classes in the Upper Peninsula lost timberland between 1966 and 1980 (table 8). Publicly owned timberland decreased by 0.16 million acres, as much of this land was reclassified as reserved timberland. Forest industry lost 0.25 million acres of its holdings in this region. Perhaps the recession of the 1970's, which hit Michigan particularly hard, made conversion of land to other uses more economically attractive. Farmer holdings of timberland fell by 0.14 million acres between 1966 and 1980, the loss occurring almost entirely in the WUP. In the EUP, the amount of cropland rose during this period, a trend which frequently coincides with increases or little change in farmer-owned timberland area. It follows that when agriculture is on the upswing in an area, the amount of timberland owned by farmers will increase. In the WUP, the large losses of farmer-owned timberland probably resulted from pressures to convert timberland to pasture and rangeland and "other" land, categories which increased between 1966 and 1980. Finally, timberland holdings of miscellaneous private owners decreased by 0.21 million acres in the Upper Peninsula between surveys. Much of this land was probably converted for development in rural areas, development made necessary by an influx of rural inhabitants.

Table 8.—*Area of timberland by owner and FIA survey unit, Lake States*

(In thousand acres)

State and survey unit	Public	Forest industry	Farmer	Miscellaneous private
Michigan[1]		(1966/1980)		
E.U.P.	1,877 / 1,754	785 / 636	483 / 478	1,024 / 934
W.U.P.	1,590 / 1,553	1,367 /1,269	331 / 194	1,633 /1,513
N.L.P.	2,786 / 2,737	73 / 76	1,045 /1,275	3,090 /2,607
S.L.P.	187 / 222	32 / 0	1,672 /1,151	926 /1,090
Wisconsin[1]		(1968/1983)		
N.E.	1,515 / 1,648	744 / 485	496 / 382	1,308 / 1,314
N.W.	2,308 / 2,082	509 / 529	1,174 / 450	1,255 / 2,089
Central	599 / 631	106 / 126	1,283 / 997	844 / 1,197
S.W.	39 / 76	7 / 0	1,234 / 1,256	214 / 589
S.E.	66 / 85	3 / 16	622 / 429	213 / 379
Minnesota		(1977)		
A.B.	3,597	535	544	775
N.P.	3,349	234	1,322	854
C.H.	328	1	1,141	481
Prairie	54	3	396	81

Notes: The data came from Chase *et al.* (1970), Jakes (1980), Spencer (1983), Spencer and Thorne (1972), Spencer *et al.* (1988), and Stone (1966).

[1] Data for Michigan, 1966, and Wisconsin, 1968, were not adjusted to be comparable with data from the succeeding inventories. Data for Minnesota, 1962, are not available.

Between 1966 and 1980, land use changes in Michigan's Lower Peninsula were similar to those in the Upper Peninsula with one notable exception. While the area of timberland declined in the NLP and the SLP (by 0.26 and 0.35 million acres), the area of reserved timberland rose (by 0.09 and 0.05 million acres), the area of cropland increased, and the area of "other" land decreased. Presumably, this decline in "other" land was not the result of converted urban lands but the conversion of land not fitting into other land classes—for example, wooded pasture. When pressures for agricultural lands became intense, evident by the large cropland increases, timberland, pasture and rangeland (which decreased in the NLP and SLP), and "other" land were converted to accommodate these demands. The acreage of "other" land decreased even though there was an increase in the Lower Peninsula's rural population.

Although the acreage of timberland decreased in the NLP and SLP between 1966 and 1980, the decreases occurred in different land ownership categories. In the NLP, miscellaneous private owners lost 0.48 million acres of their timberland and farmers gained 0.23 million acres. As in the EUP, farmers did not lose timberland when cropland acreages increased and in this case managed to increase their holdings. It appears that conversion pressures affected miscellaneous private owners, whose timberland was converted to agricultural uses. In the SLP, farmer-owned timberland decreased by 0.52 million acres while miscellaneous private owners increased their holdings by 0.16 million acres. Evidently, farmers converted their timberland for agricultural uses and some of their timberland was transferred to miscellaneous private owners.

Wisconsin

For forest inventory purposes, Wisconsin's 35 million acres of land are divided into five survey units (table 7), of which approximately 14 million acres are in the Northeast and Northwest survey units. These units are heavily forested (approximately 70 percent of the land is in forests) and sparsely populated. The Central and Southwest units cover just over 13 million acres of land, and 42 and 32 percent of their land is in forests, respectively. The Southeast unit comprises approximately 8 million acres, of which only about 0.9 million acres are forested. Over two-thirds of the State's population lives in this region.

Overall, the area of timberland increased slightly in Wisconsin between 1968 and 1983. However, this net increase was the result of more dramatic changes in timberland area in some individual survey units. In Wisconsin's Northeast and Northwest units, the area of timberland declined by 0.23 and 0.10 million acres between 1968 and 1983 (table 7). Gains in reserved timberland of 0.05 and 0.11 million acres in these units partially offset the decline in total timberland area. Timberland declines were mirrored by increases in lands used for agriculture, specifically cropland and pasture/rangeland. Concurrently, "other" land increased in the Northeast while declining in the Northwest. Presumably, timberland in the Northeast was converted to urban uses in the face of a large gain in the rural population. In the Northwest, the rural population also increased, but a great deal of "other" land, probably wooded pasture, was converted to agricultural use.

The reasons for declines in timberland in the Northeast and Northwest units are better explained by looking at changes in the ownership of these lands (table 8). In the Northeast unit between 1968 and 1983, forest industry holdings declined by 0.26 million acres, primarily due to the reclassification of Menominee Tribal lands from forest industry land in 1968 to Indian land in 1983. Farmers lost 0.11 million acres of their timberland in this unit. In the Northwest, publicly owned timberland declined by 0.23 million acres, mirroring the 0.11-million-acre increase in reserved timberland. At the same time, farmer holdings declined by 0.72 million acres. Some of this timberland was most likely converted for agricultural uses, while some was added to the holdings of miscellaneous private owners, whose share of timberland increased by 0.83 million acres.

The Central and Southwest units, in contrast to the North, showed large increases in timberland. In these units, the area of timberland increased by 0.12 and 0.43 million acres, respectively. According to Spencer *et al.* (1988), this gain was largely the result of improved stocking and subsequent reclassification of land previously used for grazing. Consequently, the amount of "other" land decreased by 0.24 and 0.41 million acres in the Central and Southwest survey units. In general, the area of agricultural land declined in these areas with the exception of an increase in pasture and rangeland in the Central unit.

Ownership of timberland in the Central and Southwest units followed a trend common to areas in which agricultural uses of the land declines. Typically, when agriculture becomes less important in an area, farmers' holdings of timberland decrease. This was the case in the Central unit, where farmer-owned timberland decreased by 0.29 million acres. At the same

time, miscellaneous private owners increased their holdings by 0.35 million acres. In the Southwest unit, miscellaneous private owners gained 0.38 million acres of timberland, while farmer holdings remained stable. In general, there was a surplus of land in these areas. Even though urban and rural populations increased dramatically between 1970 and 1980, there was enough land available to accommodate a growing population and still allow expansion of the forest area.

The Southeast unit experienced relatively little change in forest area between 1968 and 1983; however, cropland area increased substantially. Although conditions in this area were similar to those in the Central and Southwest units, it seems that wooded pasture was converted to cropland instead of reverting to forest. This situation illustrates the precedence that agricultural lands take over forest lands. When demand exists, excess lands are converted to agriculture. However, when the demand is not present, land is allowed to revert to forest. In the Southeast unit, enough land was available to satisfy demands for agricultural lands and accommodate a growing rural population.

There were exchanges of timberland between farmers and miscellaneous private owners in the Southeast unit from 1968 to 1983. In most other units, when lands used for agriculture increased in an area, farmer holdings of timberland increased or remained stable. However, in this case farmer-owned timberland area decreased by 0.19 million acres and miscellaneous private owners gained 0.17 million acres. Perhaps the large population of this area created demands for timberland to be used for recreation, or maybe miscellaneous private owners acquired timberland in anticipation of future development. In these instances, it may have been advantageous for farmers to sell their timberland to miscellaneous private owners.

Minnesota

Minnesota's 51 million acres is divided into four survey units (table 7). The Aspen-Birch unit in the northeast part of the State is a heavily forested region, with approximately 87 percent of its 9 million acres covered by forest. The Northern Pine unit is an area of 11 million acres in north-central Minnesota with about 59 percent of its area covered by forest. The lightly forested Central Hardwood and Prairie units, found in the southeastern and western portions of the State, contain a large portion of the State's population.

In all of the survey units, the area of timberland and woodland decreased between 1962 and 1977; however, the decline was partially offset in all units by increases in reserved timberland. In the Aspen-Birch unit, the area in timberland and woodland declined by 0.79 and 0.16 million acres, a 4 percent decrease in total forest area. Much of the timberland lost was reclassified as reserved timberland (a total of 0.65 million acres was added to this land class). According to Jakes (1980), the creation of Voyageurs National Park and expansion of the Boundary Waters Canoe Area Wilderness accounted for most of the transfer between timberland and reserved timberland. In the Northern Pine unit, timberland decreased by 0.27 million acres and woodland declined by 0.24 million acres. In this case, though, reserved timberland increased only 0.02 million acres. A similar pattern was observed in the other two units. In the Central Hardwood and Prairie units, timberland decreased by 0.41 and 0.25 million acres and woodland fell by 0.23 and 0.10 million acres, while reserved timberland gained only 0.04 and 0.01 million acres. Only in the Aspen-Birch unit did the reserved class gain enough acreage to significantly offset the loss of timberland and woodland.

While some of the decline in Minnesota's timberland between 1962 and 1977 was simply a transfer of timberland to the reserved timberland class, the decline also represented conversion of timberland to nonforest uses (Jakes 1980), such as cropland, urban uses, and improved pasture.

Although Minnesota's population increased between 1970 and 1980, the change was not as uniform as in the other Lake States. In Michigan and Wisconsin, the general trend was a decrease in urban populations and an increase in rural populations. However, in Minnesota, the urban populations of all survey units increased while the rural populations increased in only the Northern Pine and Central Hardwood units. The rural populations of the Aspen-Birch and Prairie units remained essentially constant.

Summary

Michigan, Wisconsin, and Minnesota cover large and very diverse areas of land. Consequently, it is difficult to make generalizations about land use trends in these areas as a whole. However, certain recurring patterns in land use are apparent that appear directly related to the ownership of the land, population growth, and population shifts.

In Michigan and Wisconsin the rural populations of all the survey units increased between 1970 and 1980; in Minnesota, increases occurred in two out of four units. In most cases, these increases were large and coincided with decreases in urban populations. An influx of new residents to a rural area results in land conversion pressures that create changes in the rural land structure.

In the Lake States, changes in the amount of land used for agriculture often coincided with changes in the size of the forest base. This trend was especially prevalent in Michigan, where declines in timberland occurred along with increases in cropland in three out of four survey units. In the other unit, pasture and rangeland increased when timberland decreased.

In Wisconsin, however, the relationship between agricultural lands and timberland was not so clear. The reason lay with land classified as "other." In Wisconsin's 1968 survey, a great deal of wooded pasture resided in this "other" category. However, by 1983 much of it had been reclassified as timberland due to improved stocking, explaining the increases in timberland in the southern part of the State. It also explained why the acreage of other land classes remained constant. Land conversion pressures simply did not exist for other land classes because of the availability of wooded pasture that could be converted to other uses.

In the Lake States, there has been observable relationships between ownership trends and land use. In general, when the amount of agricultural land increases in an area, the timberland area decreases. These changes usually coincide with increases in the amount of farmer-owned timberland and decreases in the holdings of miscellaneous private owners. For the most part, changes in timberland holdings of farmers and miscellaneous private owners oppose each other—when one increases, the other decreases. There is also a frequent connection between "other" land and ownership of timberland. When "other" land increases, it is likely that land is being converted to urban uses. When this is the case, as in Michigan's Northern Peninsula, the amount of timberland held by miscellaneous private owners decreases. When the amount of "other" land decreases, agricultural lands such as wooded pasture are probably being converted to other uses or reclassified as timberland, and the timberland holdings of miscellaneous private owners increase while farmer holdings decrease.

Plantinga, Andrew; Buongiorno, Joseph; Alig, Ralph J.; Spencer, John S., Jr. 1989. **Timberland area change in the Lake States: past trends, causes, and projections**. Res. Pap. NC-287. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 17 p.

Between the early 1960's and the mid-1980's the area of timberland in the Lake States declined by about 3 million acres. This study confirms the influences of population, economics, ownership, and trends in other land uses on timberland area. Future declines are expected, but probably at a slower rate.

KEY WORDS: Forest land, ownership, statistical model.

Our job at the North Central Forest Experiment Station is discovering and creating new knowledge and technology in the field of natural resources and conveying this information to the people who can use it. As a new generation of forests emerges in our region, managers are confronted with two unique challenges: (1) Dealing with the great diversity in composition, quality, and ownership of the forests, and (2) Reconciling the conflicting demands of the people who use them. Helping the forest manager meet these challenges while protecting the environment is what research at North Central is all about.